

WHAT IS CLAIMED IS:

1. An electrochromic element having a configuration that a reductive coloration layer and an oxidative coloration layer are arranged in a facing manner between which a solid electrolyte layer is intervened;
 - wherein said reductive coloration layer is composed of a material containing a tungsten oxide and a titanium oxide;
 - wherein said oxidative coloration layer is composed of a material containing a nickel oxide;
 - wherein a transparent intermediate layer composed of a metal oxide other than a nickel oxide or a metal or a composite comprising a metal oxide other than the nickel oxide and a metal as a main component is placed between said oxidative coloration layer and said solid electrolyte layer, and
 - wherein said electrochromic element has a gray color at the time of coloration.
2. An electrochromic element comprising a first electrode layer, a reductive coloration layer, a solid electrolyte layer, an oxidative coloration layer, and a second electrode layer laminated between two plate materials, and at least combination of a plate material at one side with the electrode layer of said two plate materials and said two electrode layers being made transparent;
 - wherein said reductive coloration layer is composed of

a material containing a tungsten oxide and a titanium oxide;

wherein said oxidative coloration layer is composed of a material containing a nickel oxide;

wherein a transparent intermediate layer composed of a 5 metal oxide other than a nickel oxide or a metal or a composite comprising a metal oxide other than the nickel oxide and a metal as a main component is placed between said oxidative coloration layer and said solid electrolyte layer, and

wherein said electrochromic element has a gray color at 10 the time of coloration.

3. The electrochromic element according to Claim 2, wherein both of said two plate materials and said two electrode layers are made transparent, the total of said element is made 15 transparent in the thickness direction thereof; and said electrochromic element is placed on an optical axis of an imaging element of a digital camera as an element for adjusting exposure.

20 4. The electrochromic element according to Claim 2, wherein one combination of a plate material at one side with the electrode layer of said two plate materials and said two electrode layers is made transparent, and the electrode layer at the other side is made of a reflecting metal film to make 25 up a reflectance-variable mirror.

5. An electrochromic element having
a substrate,
a first electrode layer formed on said substrate in a fixed
manner,
5 an oxidative or reductive coloration layer formed on said
first electrode layer in a fixed manner,
a solid electrolyte layer formed on said oxidative or
reductive coloration layer in a fixed manner,
a reductive or oxidative coloration layer formed on said
10 solid electrolyte layer in a fixed manner, and
a second electrode layer formed on said reductive or
oxidative coloration layer in a fixed manner, at least one of
said first and second electrode layers being made transparent,
wherein said reductive coloration layer is composed of
15 a material containing a tungsten oxide and a titanium oxide;
wherein said oxidative coloration layer is composed of
a material containing a nickel oxide;
wherein a transparent intermediate layer composed of a
metal oxide other than a nickel oxide or a metal or a composite
20 comprising a metal oxide and a metal as a main component is placed
between said oxidative coloration layer and said solid
electrolyte layer, and
wherein said electrochromic element has a gray color at
the time of coloration.

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6. The electrochromic element according to Claim 5,

wherein said substrate is made transparent, said first and second electrode layer are each composed of a transparent electrode film, a transparent plate-form sealing member is conjugated with said second electrode layer via a transparent sealing resin, the total of the element is made transparent in the thickness direction thereof, and the element is placed on an optical axis of an imaging element of a digital camera as an element for adjusting exposure.

10 7. The electrochromic element according to Claim 5, wherein said substrate is made transparent, said first electrode layer is composed of a transparent electrode film, said second electrode layer is composed of a reflecting metal film, and a sealing member is conjugated with said second electrode layer via a sealing resin to make up a reflectance-variable mirror whose front side is at the side of said substrate.

15 8. The electrochromic element according to any one of Claims 1 to 7, wherein said reductive coloration layer is a film of a mixture comprising a tungsten oxide and a titanium oxide as main component or a film of a mixture comprising a tungsten oxide as a main component with a titanium oxide added thereto, and said oxidative coloration layer is a film comprising a nickel oxide as a main component.

9. The electrochromic element according to any one of Claims 1 to 8, wherein atomic number of tungsten contained in said reductive coloration layer is larger than atomic number of titanium.

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10. The electrochromic element according to any one of Claims 1 to 9, wherein the proportion of titanium atom in said reductive coloration layer relative to the total atomic number of tungsten atoms and titanium atoms is from 5 to 40%, preferably 10 from 20 to 30%.

11. The electrochromic element according to any one of Claims 1 to 10, wherein said tungsten oxide comprises WO_3 as a main component, said titanium dioxide comprises TiO_2 as a main 15 component, and said nickel oxide comprises NiO as a main component.

12. The electrochromic element according to any one of Claims 1 to 11, wherein said nickel oxide contains $Ni(OH)_2$.

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13. The electrochromic element according to any one of Claims 1 to 12, wherein said reductive coloration layer is amorphous, and said oxidative coloration layer is crystalline, fine-crystalline or amorphous.

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14. The electrochromic element according to any one of

Claims 1 to 13, wherein said reductive coloration layer has the reaction represented by formulae:

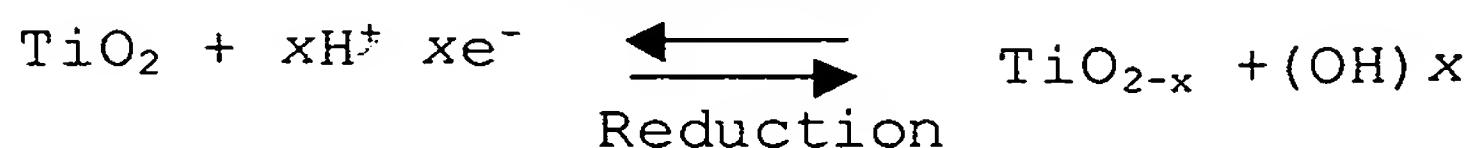
[Coloration]

[Discoloration]

Oxidation



Oxidation

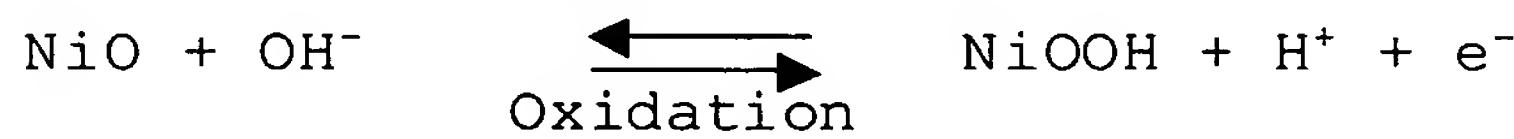


and said oxidative coloration layer has the reaction
5 represented by formulae:

[Coloration]

[Discoloration]

Reduction



Reduction



Reduction



15. The electrochromic element according to any one of
Claims 1 to 14, wherein said reductive coloration layer contains
10 components of a film formed by a two-element deposition process
utilizing WO_3 and TiO_2 as starting materials, and said oxidative

coloration layer contains components of a film formed by a deposition process utilizing NiO as a starting material.

16. The electrochromic element according to any one of
5 Claims 1 to 15, wherein the peak value at a time of coloration
is not less 1.75 V, more preferably not less than 2 V, and not
more than 3 V when both electrodes comprises transparent
electrode films, and not less than 1V and not more than 1.8 V,
when one electrode comprises a transparent electrode film and
10 the other electrode comprises a reflecting film also serving
as an electrode.

17. The electrochromic element according to any one of
Claims 1 to 16, which is colorless at the time of discoloration.

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18. The electrochromic element according to any one of
Claims 1 to 17, wherein said metal oxide making up said
intermediate layer comprises any one of SnO_2 , ZnO , In_2O_3 , ITO,
 Al_2O_3 , SiO_2 , TiO_2 , Sb_2O_5 , and ZrO_2 , or a composite of two or more
20 thereof as a main component.

19. The electrochromic element according to any one of
Claims 1 to 17, wherein said metal oxide making up said
intermediate layer comprises an electrically conductive metal
25 oxide.

20. The electrochromic element according to any one of Claims 1 to 19, wherein said metal making up said intermediate layer comprises any one of Ag, Au, Cr, Al, and Pd or a composite of two or more thereof as a main component.

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21. The electrochromic element according to any one of Claims 1 to 20, wherein said metal oxide making up said intermediate layer contains no nickel oxide or if any contains in an amount of less than 0.02, preferably less than 0.01, on 10 the weight base relative to the main component making up said intermediate layer.

22. An electrochromic element comprising a transparent intermediate layer composed of a metal oxide other than a nickel oxide or a metal or a composite comprising a metal oxide other 15 than the nickel oxide and a metal as a main component is placed between an oxidative coloration layer containing a nickel oxide and a solid electrolyte layer.

20 23. The electrochromic element according to Claim 21, wherein said metal oxide making up said intermediate layer contains no nickel oxide or if any contains in an amount of less than 0.02, preferably less than 0.01, on the weight base relative to the main component making up said intermediate 25 layer.

24. The electrochromic element according to Claim 22 or 23, wherein said metal making up said intermediate layer comprises any one of Ag, Au, Cr, Al, and Pd or a composite of two or more thereof as a main component.

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25. An electrochromic element comprising a transparent intermediate layer composed of a metal oxide other than a nickel oxide or a metal or a composite comprising a metal oxide other than the nickel oxide and a metal as a main component is placed 10 between an oxidative coloration layer containing a nickel oxide and a solid electrolyte layer., said metal oxide making up said intermediate layer contains no nickel oxide or if any contains in an amount of less than 0.02, preferably less than 0.01, on the weight base relative to the main component making up said 15 intermediate layer.

26. The electrochromic element according to any one of Claims 22 to 25, wherein said metal oxide making up said intermediate layer comprises any one of SnO_2 , ZnO , In_2O_3 , ITO, 20 Al_2O_3 , SiO_2 , TiO_2 , Sb_2O_5 , and ZrO_2 , or a composite of two or more thereof as a main component.

27. The electrochromic element according to any one of Claims 22 to 25, wherein said metal oxide making up said 25 intermediate layer comprises an electrically conductive metal oxide.

28. The electrochromic element according to any one of Claims 22 to 27, wherein said oxidative coloration layer comprises a nickel oxide as a main component.

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29. The electrochromic element according to any one of Claims 22 to 28, wherein said nickel oxide contained in said oxidative coloration layer comprises NiO as a main component.

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30. The electrochromic element according to any one of Claims 1 to 29, wherein said metal oxide making up said intermediate layer is SnO_2 and the thickness of thereof is less than 70 nm.

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31. The electrochromic element according to any one of Claims 1 to 30, wherein said solid electrolyte comprises Ta_2O_5 as a main component.